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Native Shrubs: Suitability for Revegetating Road Cuts in Northwestern Montana

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RESEARCH SUMMARY

Eighteen species of native shrubs and forbs were planted to evaluate their potential for revegetating road cuts in northern Idaho and western Montana. One-year-old seedlings were planted, both alone and in combination with grasses and legumes, in the Coram Experimental Forest in northwestern Montana. Growth, regeneration, and general condition were observed 9 years after planting.

Survival, averaged over all sites, was very good for some species: Wood's rose (82 percent), red-osier dogwood (94 percent), and thimbleberry (73 percent). Wood's rose, bush penstemon, lovely penstemon, and blackcap grew and regenerated well over the 9-year period (1974 to 1983). Most of the other species planted either died or did not grow and develop well. All species were rated for suitability based on initial survival, final survival, growth, vigor, natural spread, and potential for soil stabilization. Species attributes were listed for the eight highest rated species.

Grasses and legumes provided early surface stabilization while the roots of shrubs developed and provided deeper soil stabilization. Study results indicate that road cuts can be effectively revegetated with native shrubs. Shrub survival was not reduced by grasses and legumes.

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INTRODUCTION

Constructing roads to harvest timber or explore for minerals creates problems ranging from slope erosion and stream siltation to loss of scenic value. Revegetation can eliminate or reduce these problems. Many road cuts on National Forests in the Northern Region of the U.S. Department of Agriculture, Forest Service are seeded with grasses and legumes to aid revegetation. Fill banks respond well to this treatment, but harsh sites and cut banks usually remain barren. In these problem areas, planting appropriate shrubs and forbs can accelerate revegetation.

The use of shrubs for revegetation is not new. In the 1930's Juhren successfully used them for soil stabilization on slopes in California (Gallup 1974). Plummer (1970) reported on plants for revegetating road cuts in the Intermountain area (Utah, Nevada, and southern Idaho). Several species of shrubs have been tested for revegetating winter game ranges in southwestern Idaho (Holmgren 1954; Medin and Ferguson 1980). Plummer and others (1968) also used shrubs to restore big game habitat in Utah.

The purpose of this study was to evaluate the use of shrubs and forbs native to northern Idaho and western Montana for revegetation along western Montana road cuts. Eighteen species were chosen based on previous research results and each plant's potential for soil stabilization, availability, and survivability. The primary objective was to evaluate survival capability and soil stabilization potential of the planted shrubs and forbs on road cuts. A second objective was to evaluate shrubs and forbs together with a locally used grass and legume seeding mixture for revegetation effectiveness. Survival data 4 years after planting are presented and effectiveness for site stabilization is discussed by species. Interactions between shrubs and forbs and grasses and legumes are discussed.

STUDY AREA

An effort was made to conduct the study in representative areas along forest roads. Test sites were located on the Coram Experimental Forest (fig.1) along two logging roads: a new road and a 20-year-old road with unvegetated cut slopes. Douglas-fir/ninebark (*Pseudotsuga menziesii/Physocarpus malvaceus*) and subalpine fir/queencup beadlily (*Abies lasiocarpa/Clintonia uniflora*) habitat types are predominant in the study area. The area ranges in elevation from 4,200 to 5,200 feet (1 280 to 1 585 m) and receives an average of 33 inches (84 cm) of precipitation annually.

Approximately 3,700 feet (1 128 m) of road cuts were selected for planting on south, east, and west slopes. Cut bank slopes of ¾:1, 1¼:1, and a terraced cut through fractured rock were planted. Slope distances (from road to top of cut) varied from 10 to 70 feet (3 to 21 m). Soils along the cut banks are weathered limestone and calcareous argillites, with a pH of 7.0 to 8.0 (Klages and others 1976). Subsoils (from the B and C horizons) and fractured rock range in depth from 0 to 4 feet (0 to 1.2 m) below the undisturbed surface. Soil structure varies from weak, fine, subangular blocky to massive, with 20 to 80 percent rock. Soil texture varies from gravelly, silty clay loam to gravelly silt loam. The soils in the study area are characterized by a low organic content (0.6 to 1.4 percent) and a cation exchange capacity (CEC) of 8.2 to 19.6 meq/100 g. Soils contain from 0.03 to 0.07 percent total nitrogen and 3.8 to 28.0 ppm available phosphorus.

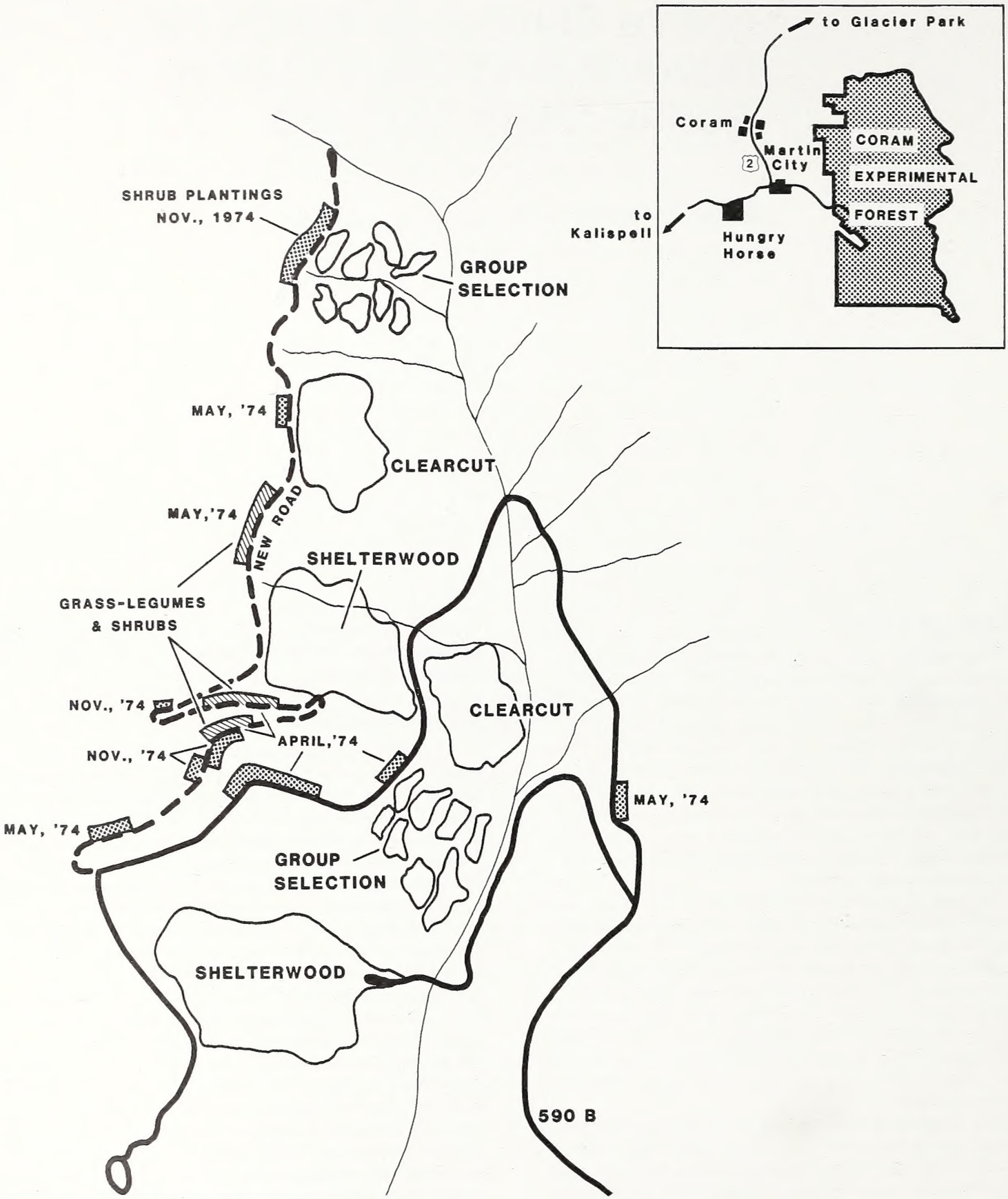

Figure 1.—Location of shrub planting sites on the Coram Experimental Forest, showing the new road and old road. Location of grass and legume plantings is shown.

METHODS

Shrubs and Forbs

Information about shrub species and their effectiveness in revegetation was obtained from published sources (Plummer and others 1968; Plummer 1970), the field experience of Monsen (at the Intermountain Station's Forestry Sciences Laboratory in Boise, Idaho) and Jensen (at Montana State University in Bozeman, Mont.), and the results of plantings on the Colville and Coeur d'Alene National Forests (Mason and others 1973). From this information, a list of species suitable for planting study sites was compiled, based on species' adaptability and their potential for soil stabilization. The 18 species of shrubs planted in the study areas (appendix 1 lists species by common and botanical names) were species from this list that were available from the nursery.

Plants were obtained from the Coeur d'Alene Nursery as 1-year-old bare-rooted plants in the fall of 1973 and 1974. Plants received in October 1973 were heeled in (stored in trenches with roots covered with moist soil) for the winter and planted the following spring. This spring planting consisted of 15,000 plants. An additional 2,500 plants, received in October 1974, were heeled in until planted in November 1974.

Shrubs were planted every 2 feet (0.6 m) in vertical rows 3 feet (0.9 m) apart. The planters used ladders to facilitate planting on steep cut banks in the study areas (fig.2). Hoedads were used to make holes, and any available soil was backfilled around the plants.

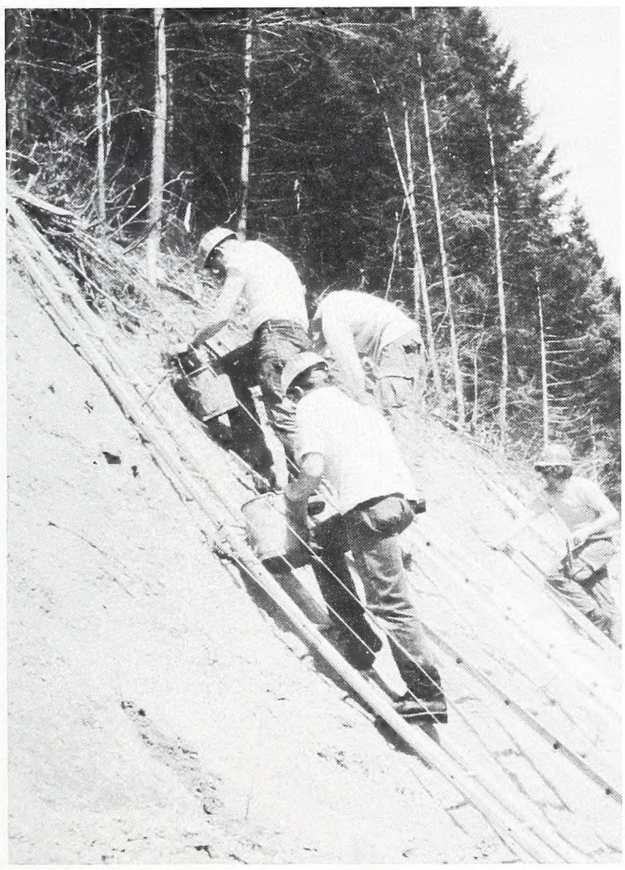

Figure 2.—Planting on road cuts using ladders to provide footing for the planter and reduce site disturbance.

Spring planting began in mid-April 1974, and concluded in early May. Climatic conditions during planting were generally good, with the exception of a few warm, dry days during the first week. Snow on some of the slopes created adverse planting conditions by mixing with the soil around the roots of the plants. Conditions during fall planting in November 1974 were adverse; the weather was cold and snowy, and soils were frozen on one site.

The overall condition of the planting stock was very good. Silvery lupine and snowbrush (also called evergreen or shinyleaf ceanothus) plants in both shipments were in poor condition. Saskatoon serviceberry plants received in 1974 were extremely small and in poor condition. Wood's rose plants received in the 1974 shipment were substantially larger than those received in 1973. At the time of spring planting, most of the curl-leaf mountain-mahogany stock was in less than satisfactory condition, possibly due to damage while heeled in.

Survival was based on the percentage of plants living 4 years after planting. Shrubs planted with grass and legumes (described below) were included. Overall planting success was determined subjectively after 9 years. Criteria for this subjective evaluation were based on the work of Nord (1977) and adaptability attributes similar to those of Plummer (1977). These adaptability attributes were used to develop a suitability index similar to that used by Plummer and others (1968). Criteria (rating factors) for the suitability ratings were: **survival**, based upon first- and fourth-year evaluations; **growth**, based on size and spatial development typical for the species; **vigor**, based on flowering frequency and appearance; **natural spread**, based on type of regeneration and degree of plant spreading; and **soil stabilization**, based upon observed holding capabilities and the extent of root systems.

Flowers, vegetative color, and form can add to the visual acceptability of revegetated road cuts. These factors are especially significant in high use areas. Although not included with the above criteria, some evaluations of visual acceptability are included in the Results and Discussion section.

Shrubs and Forbs with Grasses and Legumes

On three road cuts shrubs were planted, as described above, along with a grass and legume mixture, a fertilization treatment, and a straw mulch treatment in the spring of 1974. For these tests seven shrub species and a seeding mixture used by the Flathead National Forest were used (appendix 2). The seeding mixture was applied with a cyclone seeder in a single application at a rate of 13 lb/acre (14.6 kg/ha). (Rates for each species are given in appendix 2.) Fertilizer was applied in a single application with a cyclone seeder at a rate of 250 lb/acre (280 kg/ha) of 16-20-0 (40 lb/acre [44.8kg/ha] actual nitrogen and 50 lb/acre [56kg/ha] actual phosphorus). A randomized block design (Steel and Torrie 1960) was used, giving 12 experimental units or treatment combinations. More details of the treatments and methodology are given in appendix 2.

Ground cover was sampled for each plot 4 years after planting, using ten 20- by 50-cm quadrats on each plot. Analysis of variance procedures were used to evaluate treatment differences.

RESULTS AND DISCUSSION

Survival

Of the 18 species of plants used in this study, six (Wood's rose, red-osier dogwood, thimbleberry, blackcap, bush penstemon, and lovely penstemon) showed good survival (47 percent or more) 4 years after planting (table 1). These species show promise for road cut revegetation in western Montana and northern Idaho. Four other species (redstem ceanothus, spirea, ninebark, and snowbrush) did well in some rating categories but not in others. The other eight species exhibited poor survival and growth or poor growth and rooting characteristics.

Initial survival (assessed at the end of the first growing season) was $\geq$ 70 percent for six species (Wood's rose, red-osier dogwood, blackcap, thimbleberry, black chokecherry, and blue elderberry). Of these, red-osier dogwood, Wood's rose, and blue elderberry exhibited survival rates $\geq$ 87 percent. Low survival rates were noted for silvery lupine (2 percent), ocean-spray (8 percent), and snowbrush (24 percent).

Survival was evaluated in 1978, 4 years after transplanting (table 1). Red-osier dogwood, Wood's rose, and thimbleberry maintained 70 percent or better survival. Black chokecherry and blackcap survival dropped to about 55 percent after the first year, and blue elderberry survival dropped to 30 percent. For most species, losses were sustained primarily during the first growing season, and less than 20 percent loss occurred in following seasons.

A number of factors influenced survival and plant development. Seed source, or origin of plant materials, is one factor. Seed source may have had an effect on the results of this study, but since plant materials were limited, testing for the effect of source was not possible. General location of seed source is given by National Forest in appendix 3.

Planting condition also influenced survival. One cut bank was planted during unseasonably warm spring weather and another was planted during snowstorms on frozen soil in the fall. Severe slumping occurred on both sites and resulted in much mortality. Slumping was not related to planting conditions. First-year survival for Wood's rose was good on both sites (77 percent on spring site and 61 percent on fall site); bush penstemon had good survival (50 percent) on the fall site. First-year survival for all other species was substantially lower than for the average of all other sites. Subsequent losses for established plants of all species on these sites were similar to other cut banks, suggesting that once plants become established under adverse conditions they continue to survive. Survival for cuts on the new road was similar to that on the 20-year-old road.

Aspect appeared to be a significant factor in the survival of lovely penstemon, redstem ceanothus, and spirea (fig. 3). Survival of these species was significantly lower on the western aspect than on either the southern aspect or the eastern aspect. Perhaps high solar energy late in the day causes added moisture stress. Species on the eastern and southern aspects had similar survival rates. Aspect differences might play a more significant role in survivability at lower elevations and in regions with less precipitation than the study sites.

Browsing by wildlife or livestock did not influence survival on these trials. Although elk and deer are in the area, few plants show signs of browsing. Grazing can be a factor in survival of plantings, depending on the forage value of the plants used and the availability of forage in the surrounding area.

Precipitation data obtained from Hungry Horse Dam 5 miles (8 km) south of the study area and stations in the study area showed that precipitation was nearly

Table 1. — Species average survival 4 years following planting

Species	Total number planted	Spring planting 1974	Fall planting 1974	All plantings
		Percent		
Wood's rose	1,424	93	62	82
Red-osier dogwood	93	94		94
Thimbleberry	59	73		73
Saskatoon serviceberry	1,515	68	12	46
Black chokecherry	1,401	65	25	53
Spirea	473	57	45	57
Blackcap	64	55		55
Lovely penstemon	674	36		36
Bush penstemon	411		51	51
Ninebark	134	60	22	49
Blue elderberry	31	30	50	32
Redstem ceanothus	1,534	32	14	26
Smooth sumac	88	20	14	17
Black elderberry	23	9		9
Curl-leaf mountain-mahogany	29	7		7
Snowbrush	1,436	11	4	9
Silvery lupine	653	1		1
Ocean-spray	50	2		2

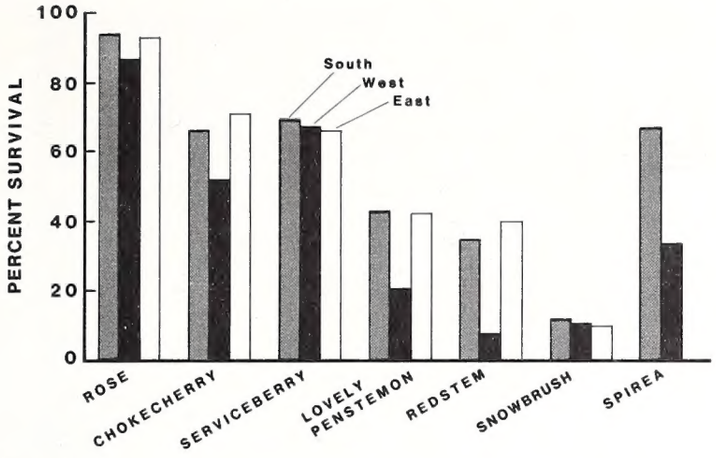

Figure 3.—Overall survival of 4-year-old plants by aspect for those species planted on more than one aspect.

normal from 1974 through 1978, with two exceptions. August 1974 had 1.13 inches (2.87 cm) less rain than normal, which could have contributed to lower initial survival for some species. May through August 1976 had 4.5 inches (11.43 cm) more rain than normal, which could have only been beneficial for plant development.

Mold on the roots and poor plant condition were the primary causes of poor survival of snowbrush (9 percent), silvery lupine (1 percent), and redstem ceanothus (24 percent). Where individuals of these species became established they did reasonably well, which suggests that these species might be useful for site revegetation if stock was improved. A lack of nitrogen-fixing bacteria in these species may have contributed to plant failure. Inoculating plants with rhizobium bacteria may improve plant survival.

Curl-leaf mountain-mahogany stock was in poor condition at the time of planting. It was necessary to discard most of the plants, and of the few planted, survival reached only 7 percent by 1978. Poor plant quality and site disturbance after planting appear to be the most plausible explanations for the low survival rate. Plants that became established remained in good condition after 9 years (fig. 4), even though this species is out of its natural range in the study area.

Initial survival of blue elderberry, black elderberry, and smooth sumac was fair to good, but after 4 years only 30 percent of the plants were still alive. After 9 years only one elderberry plant could be found. Factors influencing species mortality appeared to be the hot, dry slopes and the unfertile rocky soil.

Ocean-spray was expected to perform well on the test sites, but both initial and 4-year survival rates were low (4 percent after 4 years). Unhealthy nursery stock and poor soils may have been responsible for mortality.

Figure 4.—A healthy 9-year-old curl-leaf mountain-mahogany plant provides a protective surface covering and a good root system to hold soil. This plant is 4 feet (1.2 m) tall and 3.5 feet (1.0 m) wide.

Growth

As a measure of success for road cut stabilization and visual enhancement, transplants were expected to grow and spread to provide adequate ground cover and be noticeable from roadways. After 9 years, Wood's rose, bush penstemon, and lovely penstemon were the only species reaching or even approaching their potential size at all planting sites (figs. 5, 6, and 7; table 2). Many Wood's rose plants grew to a height of 3 feet (0.9 m) or more and branched or spread horizontally 2 feet (0.6 m) in radius from the planting. Bush penstemon, a low-growing, mat-forming plant, reached or exceeded its expected size on many of the sites, attaining a basal diameter of up to 4 feet (1.2 m) (fig. 6). Lovely penstemon, a slightly taller plant (without the basal mat-forming tendencies) (fig. 7), reached its expected potential, attaining heights of 2 feet (0.6 m) and diameters of 2 feet (0.6 m), even though this site is out of its natural range. Red-osier dogwood developed well (fig. 8), but not with site uniformity. On several sites, these plants reached heights of 6 feet (1.8 m) and branched well, approaching the maximum size for this species. Plants on the drier cut banks did not develop as well, reaching heights of 3 to 4 feet (0.9 to 1.2 m), but were likely to continue growing. This species did much better than expected on these sites. Red-osier dogwood is generally known as a moist-site plant and to grow and survive as well as it has on these south aspects is surprising.

Figure 5.—A row of 7-year-old plants of Wood's rose showing how plants have branched out by sprouting. This presents a very effective ground cover with the ability to hold soil on this rocky road cut. Plants are about 4 feet (1.2 m) tall and 4 feet (1.2 m) wide.

Figure 6.—Six-year-old bush penstemon plants have expanded to form dense mats 3 feet (0.9 m) in diameter with attractive flowers. Soil on the steep bank is effectively stabilized.

Figure 7.—Lovely penstemon on a rocky road cut has expanded and holds loose soil material. Branching is more loosely arranged without forming mats. Flowers are produced frequently and resemble those on bush penstemon. Many new seedlings are established from seed. This site is out of the native range of this species.

Figure 8.—A 9-year-old red-osier dogwood on a steep south slope provides good ground cover and stabilization. Crowns spread to 6 feet (1.8 m) wide and 4 feet (1.2 m) tall and are quite attractive.

Table 2. — Attributes of eight most suitable species

Species	Location	Elevation	Microsite	Moisture soils	Foliage	Height	Root type	Flowers	Forage quality	Propagation	Success	Reference
						Feet						
Wood's rose	Inland NW	Low to high	Open to light shade	Dry to moist	Deciduous	1-4	Rhizomes	Small showy pink	Fair	Seeds vegetative	Excellent	Mason and others 1973 Monsen, Christensen 1975 Plummer and others 1968 USDA 1974 USDA 1937 Hitchcock, Cronquist 1973
Bush penstemon	Inland NW	Low to high	Open slopes	Dry, rocky	Evergreen	1-2	Rootstalks	Large showy lavender	Fair	Seeds layering	Good	Plummer 1977 Plummer and others 1968 Davis 1952 Hitchcock, Cronquist 1973 USDA 1937
Lovely penstemon	NE Oreg. SE Wash. N Idaho	Low to mid	Open slopes	Dry, rocky	Evergreen	1-2	Rootstalks	Large showy lavender	Fair	Seeds layering	?	Davis 1952 Hitchcock, Cronquist 1973
Red-osier dogwood	Northern North America	Low to high	Open to shaded	Moist good soils	Deciduous	5-20	Fibrous "root crown"	Small white	Fair to good	Seeds layering	Good	Mason and others 1973 Plummer 1977 USDA 1974 Hitchcock, Cronquist 1973
Blackcap	Widespread in U.S. & Canada	Lower	Open to open woods	Moist good soil	Deciduous	5-7	Rootstalks	Small	Fair to poor	Seed layering	?	USDA 1974 Hitchcock, Cronquist 1973
Thimbleberry	Widespread western U.S.	Sea level to subalpine	Open to wooded	Dry-rocky to moist loams	Deciduous	2-3	Rhizomes	Large showy	Poor to fair	Vegetative	?	USDA 1937 Hitchcock, Cronquist 1973
Redstem ceanothus	Coastal to inland NW	Low to mid	Open to open woods	Moist	Deciduous	3-10	Fibrous "root crown"	Showy	Good to excellent	Seed	Variable	Hitchcock, Cronquist 1973 USDA 1974 USDA 1937
Spirea	Widespread western U.S.	Sea level to subalpine	Open to wooded	Dry to moist	Deciduous	1-3	Rhizomes	Showy	Poor to fair	Vegetative	?	USDA 1937 Hitchcock, Cronquist 1973

Redstem ceanothus (fig. 9), spirea, and thimbleberry developed well on selected sites, but, overall, plants remained small (table 3). Black chokecherry and Saskatoon serviceberry exhibited lackluster development. Both plants averaged 1½ to 2 feet (0.5 to 0.6 m) tall except on eastern aspects where some plants reached heights of 3 to 4 feet (0.9 to 1.2 m). No black chokecherry or Saskatoon serviceberry plants reached sizes typical for their species.

Blackcap plants reached typical size (5- to 7-foot [1.5- to 2.1-m] canes) on some sites. Overall, blackcap did well on south aspects. Other species, except silvery lupine and snowbrush, did not increase in size or vigor. Those few plants of silvery lupine and snowbrush that became established on these slopes did attain typical size.

Vigor and Natural Spread

Ground cover and soil stabilization were enhanced when test species spread via vegetative propagation or seedling establishment. Two indices of these attributes were plant flowering and the presence of new plants. The ability to flower and reproduce also indicates good vigor and health. Of the 18 species used during this study, Wood's rose, bush penstemon, and lovely penstemon excelled in these types of development at most of the planting sites. Wood's rose plants increased by sprouting from the roots, to the extent that it became difficult to distinguish individual plants. The proliferation of flowers (fig. 10) and fruits observed on these plants indicate that establishment of new plants from seed may also occur.

Bush penstemon and lovely penstemon spread through seedling establishment. Bush penstemon plants on several sites flowered prolifically, displaying attractive lavender flowers (fig. 6). New bush penstemon plants were discovered on the cuts (fig. 11), in the ditch, and on the shoulder and fill banks across the road from planting sites (where plants were not present prior to planting). Lovely penstemon seedlings were restricted to the cut banks.

Spirea and blackcap flowered regularly on some planting sites and spread, although to a limited extent,

Figure 9.—A healthy 9-year-old redstem ceanothus plant on this steep south-facing road cut stabilizes the soil and protects the surface. The plant is 4 feet (1.2 m) tall and wide.

Table 3. — Species suitability ratings

Species	Initial survival	Final survival[1]	Growth	Vigor[2]	Natural spread	Soil stabilization[3]	Composite rating[4]
Wood's rose	9	9	9	8	10	10	55
Bush penstemon	6	9	10	10	10	8	53
Lovely penstemon	5	8	10	10	8	8	49
Red-osier dogwood	10	10	8	9	2	8	47
Blackcap	8	6	7	8	7	8	44
Thimbleberry	8	9	5	5	4	6	37
Redstem ceanothus	5	6	8	7	2	8	36
Spirea	6	9	5	4	5	4	33
Ninebark	6	8	5	5	0	4	28
Snowbrush	2	4	6	6	2	8	28
Blue elderberry	10	3	2	5	0	6	26
Black chokecherry	7	8	2	2	0	2	21
Saskatoon serviceberry	6	8	2	2	0	2	20
Smooth sumac	5	4	4	4	0	3	20
Curl-leaf mountain-mahogany	4	2	4	5	0	4	19
Silvery lupine	1	5	5	3	0	2	17
Black elderberry	5	2	2	2	0	2	13
Ocean-spray	1	2	2	2	0	2	9

[1]Final survival based on percentage of initial survivors alive after 4 years.
[2]Based on flowering growth rate and appearance.
[3]Based on root system and observed holding power.
[4]Ratings for each factor are based on a scale from 0 to 10, with 10 being the best.

Figure 10.—Wood's rose plants have attractive flowers and provide a protective soil covering.

Figure 11.—Bush penstemon plants grow on rocky sites and spread by seed. New plants are located in the ditch and to the side of the original rows. Closeness of plants in the row demonstrates plant expansion and new plants. A good ground cover that is effective in stabilizing soils is produced.

on sites where it was able to establish well. Blackcap exhibited vegetative spread quite similar to that of Wood's rose. None of the other species successfully regenerated by seed or root propagation.

Soil Stabilization

As previously discussed, growth and natural spread contribute to stabilization of soils on the cut banks. Surface coverage exhibited by Wood's rose (fig. 4) and the mat-forming bush penstemon (fig. 10) protect the surface and hold the soil against water and wind. These plants can grow on, survive on, and enhance the appearance of very rocky sites (fig. 12). Root type and depth are important for holding deeper layers (table 2). Plants with rhizomes, such as Wood's rose, blackcap, thimbleberry, and spirea, may function better in holding soil than plants with other types of root systems. Wood's rose and blackcap plants developed extensive rhizomes on the study sites. This was not observed for thimbleberry or spirea. Root systems for lovely and bush penstemons were well developed and seemed to hold soil well on these steep cut banks. Other species, such as red-osier dogwood, redstem ceanothus, and snowbrush, develop deep root systems and provide good stabilization where plants grow well.

Suitability Ratings

Overall assessment of species suitability was based on survival, growth, vigor, natural spreading, and soil stabilization. Species were ranked according to these factors (table 3). Wood's rose achieved the highest ranking, with bush penstemon and lovely penstemon second and third and red-osier dogwood fourth. Wood's rose scored well in all categories, indicating good potential for cut bank stabilization. Red-osier dogwood achieved a high ranking because of its high survival

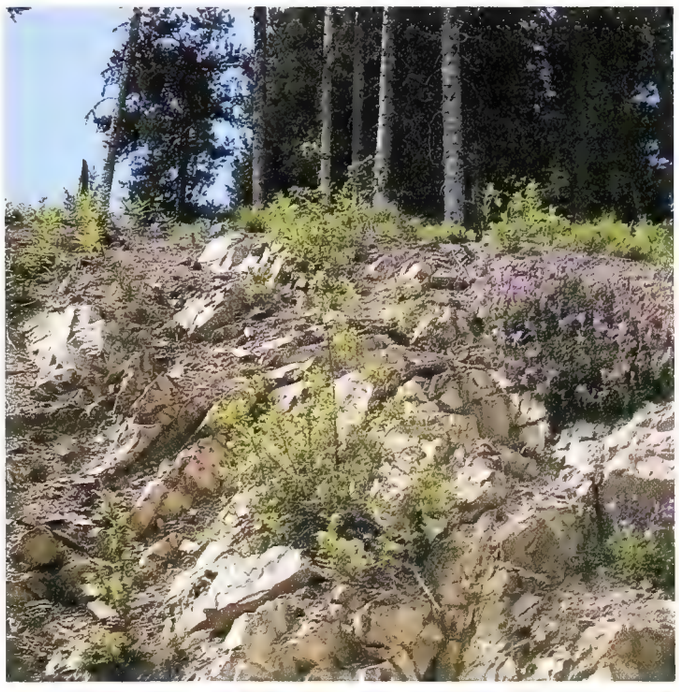

Figure 12.—Appearance of this rocky road cut is improved by flowering bush penstemon, Wood's rose, and black chokecherry plants. These plants have persisted for 9 years with good growth.

rates, but it did not show evidence of natural spreading. Red-osier dogwood, though it performed surprisingly well, cannot be assumed to be as well adapted to the study sites as both penstemons. Both penstemons

achieved as favorable a rating as Wood's rose in all areas of consideration except survival. (The survival rate of the penstemons was $\simeq$ 50 percent, which could probably be improved through better nursery stock and planting techniques.)

Survival rates of black chokecherry, Saskatoon serviceberry, and ninebark were good on some sites; however, poor or mediocre performance of these species in other rating categories, particularly size increase, affected their standing in the overall ranking of test species. Poor soil conditions and the harsh site environment were the most probable factors affecting plant growth, although the extremely small size of the plants received for the second planting also influenced plant development.

Blackcap, spirea, and thimbleberry were considered suitable for selected sites due to good survival rates and moderate growth. Redstem ceanothus did well in all categories except survival and natural spread. Survival may be enhanced if problems with planting stock were overcome.

Grasses, Legumes, and Shrubs

The results of using grasses, legumes, and fertilizer in conjunction with shrubs at selected sites were as expected. Plots with no treatment sustained a ground cover of 2 to 18 percent at the end of 4 years. Fertilized plots had 4 to 25 percent cover. Those plots seeded with grasses and legumes produced a cover of 9 to 44 percent. The highest average ground cover resulted on plots treated with grasses, legumes, shrubs, and fertilizer. Analysis of variance showed that grass and fertilizer significantly influenced ground cover on only one cut bank. Differences were not significant at other sites. The appearance of the banks with grasses, legumes, and shrubs was much better than those with bare soils (fig. 13).

Survival rates for shrubs planted on plots seeded with grasses and legumes were as good or better than for shrubs planted alone. Planting grasses and legumes resulted in rapid development of ground cover and protection against surface erosion while shrubs took root. Birdsfoot-trefoil grew well, and provided an attractive cover of prolific yellow blooms on all the seeded cut banks (fig. 13). Seed crops were good, as evidenced by the spreading and regeneration of new plants in areas where it was not seeded. Smooth brome-grass and orchard-grass also did well, especially on fill bank sites.

Figure 13.—Grasses and legumes form a good ground cover on this south slope 6 years after planting. The area to the left in the photo was not seeded or planted. Birdsfood-trefoil produced numerous attractive yellow flowers and spread naturally by seed.

CONCLUSIONS

Planting of native shrubs proved to be an effective means of revegetating road cuts in northwestern Montana. Once established, esthetically pleasing flowers contributed to the overall suitability of the shrub plantings, while unattractiveness of many species as forage insured their continued growth.

Of the species studied, Wood's rose demonstrated the best survivability and regeneration characteristics, even on harsh sites. These findings concur with those of Mason and others (1973), documenting the growth of this species on severe road cuts in the Northern Region of the Forest Service.

Bush penstemon and lovely penstemon exhibited good potential for use in revegetation. Spreading, regeneration, and adaptability to both dry and moist sites were excellent. Plummer (1977) and Monsen and Christensen (1975) also found bush penstemon adaptable to sites within the Intermountain Region.

Several other species studied grew well, indicating their usefulness in site revegetation. Species in this category included thimbleberry and blackcap on south aspects; redstem ceanothus and spirea on east aspects. Red-osier dogwood did exceptionally well on south aspects, considering that this species is a riparian shrub.

Mechanized planting methods are available for steep road cuts, but may not be cost effective unless large areas are treated. Hand planting and seeding techniques will be very useful and quite effective where it is necessary to revegetate road cuts or steep slopes on a small scale. Hand-planting techniques are also more easily adapted to fit the users' needs.

A further concern is the availability of native shrubs and seeds. Commercial nurseries can provide some species, but special arrangements for seed collection and propagation of other species may be necessary. Advanced planning is necessary to select adapted species and assure good condition of stock at planting time. This planning can go a long way toward insuring the ultimate success of a revegetation project.

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APPENDIX 1: COMMON AND BOTANICAL NAMES OF SPECIES

Common name	Botanical name[1]
Blackcap	*Rubus leucodermis* Dougl.
Black elderberry	*Sambucus racemosa* ssp. *pubens* var. *melanocarpa*
Blue elderberry	*Sambucus cerulea* Raf.
Black chokecherry	*Prunus virginiana* var. *melanocarpa* (Nels.) Sarg.
Silvery lupine	*Lupinus argenteus* Pursh
Curl-leaf mountain-mahogany	*Cercocarpus ledifolius* Nutt.
Mallow ninebark	*Physocarpus malvaceus* (Greene) Kuntze
Ocean-spray	*Holodiscus discolor* (Pursh) Maxim.
Bush penstemon[2]	*Penstemon fruticosus* (Pursh) Greene var. *fruticosus*
Lovely penstemon[2]	*Penstemon venustus* Dougl. ex Lindl.
Redstem ceanothus	*Ceanothus sanguineus* Pursh
Red-osier dogwood	*Cornus stolonifera* Michx.
Saskatoon serviceberry	*Amelanchier alnifolia* Nutt.
Snowbrush	*Ceanothus velutinus* Dougl.
Spirea	*Spiraea betulifolia* Pall.
Smooth sumac	*Rhus glabra* L.
Thimbleberry	*Rubus parviflorus* Nutt.
Wood's rose	*Rosa woodsii* Lindl.
Alta tall fescue	*Festuca arundinacea* Schreb.
Manchar smooth brome	*Bromus inermis* Leys.
Orchard-grass	*Dactylis glomerata* L.
White Dutch clover	*Trifolium repens* L.
Birdsfoot-trefoil	*Lotus corniculatus* L.

[1]Nomenclature is after Hitchcock and Cronquist 1973.

[2]Identifications were made by Peter F. Stickney, Forest Service, Intermountain Forest and Range Experiment Station, Forestry Sciences Laboratory, Missoula, Mont.

APPENDIX 2: TREATMENTS USED IN GROUND COVER EVALUATIONS

Treatments and Levels

Fertilizer

1. None
2. 250 lb/acre (280 kg/ha) of 16-20-0

Grass-legume seedings

1. None
2. Grass and legume mixture seeded without straw mulch
3. Grass and legume mixture seeded with straw mulch

Shrubs planted

1. None
2. Seven species[1] were used

The above treatments were applied using all 12 combinations and replicated once on one cut bank and twice on two cut banks. One cut bank was east-facing and the other two faced south. All of these cuts were along the new road. Fertilizer treatment amounted to approximately 40 lb/acre (44.8 kg/ha) of available nitrogen and 50 lb/acre (56 kg/ha) available phosphorus as a one-time application. Twelve plots at each replication were 27 to 48 feet (8.2 to 14.6 m) wide and length went from the road to the top of the cut bank. Seeding and planting were done in April and May 1974. No fall seedings were used. Ground cover evaluations were made in 1978 using a 7.9- by 19.7-inch (20- by 50-cm) plot frame. Ten samples were taken on each plot to obtain average cover for the plot. Analysis of variance procedures were used to test for treatment differences.

[1]Wood's rose, Black chokecherry, Redstem ceanothus, Lovely penstemon, Silvery lupine, Saskatoon serviceberry, Snowbrush

Grass and legume mixture

Species	Seeding rate	
	Lb/acre	*kg/ha*
Alta tall fescue	2.5	2.8
Manchar smooth brome	4.0	4.5
Orchard-grass	2.5	2.8
White Dutch clover	2.0	2.2
Birdsfoot-trefoil	2.0	2.2

APPENDIX 3: SEED SOURCE FOR PLANTS RECEIVED FROM THE COEUR D'ALENE NURSERY

Species	Location
Blackcap	Coeur d'Alene National Forest
Black elderberry	Coeur d'Alene National Forest
Blue elderberry	Coeur d'Alene National Forest
Black chokecherry	Coeur d'Alene and Okanogan National Forests
Silvery lupine	Okanogan National Forest
Curl-leaf mountain-mahogany	Montana
Ninebark	Lolo National Forest
Ocean-spray	Coeur d'Alene National Forest
Bush penstemon	Lolo National Forest
Lovely penstemon	Idaho
Redstem ceanothus	Idaho
Red-osier dogwood	Coeur d'Alene National Forest
Saskatoon serviceberry	Idaho
Snowbrush	Okanogan National Forest
Spirea	Coeur d'Alene National Forest
Smooth sumac	Colville National Forest
Thimbleberry	Okanogan National Forest
Wood's rose	Kootenai National Forest

Hungerford, Roger D. Native shrubs: suitability for revegetating road cuts in northwestern Montana. Research Paper INT-331. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station; 1984. 13 p.

Four years after planting, Wood's rose (82 percent), red-osier dogwood (94 percent), and thimbleberry (73 percent) had the highest survival of the 18 species of native shrubs planted on steep road cuts in northwestern Montana. Two penstemon species and Wood's rose demonstrated good growth and regeneration 9 years after planting. Several of the species tested can be valuable for revegetating road cuts, stabilizing slopes, and improving their appearance. Species suitability is rated and important attributes are given for the species that rated the highest.

KEYWORDS: revegetation, soil stability, road cuts, shrubs

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